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ABSTRACT

This study investigated two methods for establishing a systematic, selective, attending strategy in a memory task for children. One method was direct training of a specific strategy, employing instructions, fading, modeling, and prompts to direct the child's attention to the relevant features and to organize systematic looking behavior. The second method involved the design of the stimuli, making relevant features perceptually more (or less) salient. Observing behavior and short-term recognition were studied. Sixty 3 1/2-to-5 1/2-year-old children matched pictures from memory with either strategy training for systematic scanning or placebo practice followed by transfer. One-third of the subjects in each condition saw stimuli with relevant portions made perceptually salient, another third with irrelevant portions salient, and the rest with no portions salient. Strategy training enhanced systematic relevant observing behavior and facilitated recognition in both training and transfer. Stimulus saliency, when irrelevant, interfered in training for placebo subjects. Saliency directly influenced looking behavior only for young subjects in the early part of each trial. (Author/SB)

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# ATTENTION AND COGNITIVE STYLES

John C. Wright

Principal Investigator

PS 008778

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March 1 through September 15, 1973

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KANSAS CENTER FOR RESEARCH IN EARLY CHILDHOOD EDUCATION

Department of Human Development
University of Kansas

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TABLE OF CONTENTS


| TITLE | MILESTONE (as specified in scope-of-work) |
| --- | --- |
| a. The Effect of Strategy Training, Stimulus Saliency, and Age on Recognition in Preschoolers | Salience and relevance of cues, age, and strategy training as determinants of systematic scanning and short-term memory. |

Alice G. Vlietstra and John C. Wright

# THE EFFECT OF STRATEGY TRAINING, STIMULUS SALIENCY, AND AGE ON RECOGNITION IN PRESCHOOLERS[1]

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# THE EFFECT OF STRATEGY TRAINING, STIMULUS SALIENCY, AND AGE ON RECOGNITION IN PRESCHOOLERS[1]

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Based on a paper scheduled, but not presented at the biennial meeting of the Society for Research in Child Development, Philadelphia, March, 1973. The paper was presented at the annual meeting of the American Psychological Association, Montreal, Canada, August, 1973.

ABSTRACT

Observing behavior and short-term recognition were studied in a training and transfer design. Three- to- five-year-olds matched pictures from memory with either strategy training for systematic scanning or placebo practice followed by transfer. One-third of the subjects in each condition saw stimuli with relevant portions made perceptually salient, another third with irrelevant portions salient, and the rest with no portions salient. Strategy training enhanced systematic relevant observing behavior and facilitated recognition in both training and transfer. Stimulus saliency, when irrelevant, interfered in training for placebo subjects. Saliency directly influenced looking behavior only for young subjects in the early part of each trial.

# INTRODUCTION

The present study examines three facets of children's attentional behavior in relation to learning and short-term memory. They include the development of systematic attentional strategies, the source of control of attentional behaviors, and the focusing of attention on relevant stimulus dimensions.

A number of studies have indicated developmental changes in these facets of attention. In both the haptic (active touch) and visual sensory modalities, partial and passive attentional behaviors in young children is replaced in older children by more active, systematic, and exhaustive strategies of search (Abravenel, 1968; Drake, 1970, Vurpillot, 1968; Zaporozhets, 1965). Vurpillot (1968), in a study where children's eye movements were recorded while performing a "same-different" judgment task, found that children three to six years of age scanned the stimuli partially and made judgments (frequently erroneous) on the basis of insufficient information. At about age five, more systematic, active, and exhaustive scanning strategies began to appear and were adopted by most children over six years of age, with correspondingly increased accuracy.

In a second developmental trend, passive control of attention by stimulus properties gives way in older children to attention controlled

by logical task demands. When stimuli are organized in perceptual displays, young children's search behavior, whether it be naming the stimuli (Elkind & Weiss, 1967) or asking questions (Ault, 1973; Van Horn & Bartz, 1968) is guided by the organization inherent in the perceptual display. Older children's search behavior, on the other hand, is more task- and logic-guided, regardless of the perceptual organization provided (Olson, 1966; Mosher & Hornsby, 1966). Similarly, when children are presented a task containing a preferred and a non-preferred stimulus dimension, young children explore the preferred dimension more often than older children, regardless of whether it is relevant. Older children (fourth-graders) are more able to ignore their preferred dimension and respond to that which is relevant (Lehman, 1972).

Other studies suggest an increased selectivity of attention with age (Lehman, 1972; Maccoby & Konrad, 1966; 1967; Siegel, 1968; Pick, Christy, & Frankel, 1972). Older children, when told on which dimension multidimensional stimuli are to be compared, react faster to the information presented on that dimension than younger children (Pick et al., 1972) and restrict their attention to that dimension more than younger children (Lehman, 1972).

Correlated with these developmental changes in children's attentional behaviors is an improvement with age in children's learning and memory. This improvement in children's learning and memory with age may be directly related to their attentional

processes. When selective attention to a relevant dimension on a learning task is enhanced, either by pretraining choices on that dimension (Caron, 1969; Tighe, 1965), or by an assessed preference for that dimension (Smiley & Weir, 1966; Tighe, Tighe, Waterhouse, & Vasta, 1970), or by training specific attentional behaviors to that dimension (Wright & Gliner, 1968), subsequent learning on that dimension is facilitated so long as that dimension or feature is relevant (Caron, 1969; Tighe, et al., 1970) and impeded when it is irrelevant (Smiley & Weir, 1966).

There are few studies on the relation between attention and memory. In one series of studies on memory development, Haith (1971) found that five-year-old children performed as well as adults on a memory task when only one stimulus was presented at a time. If many stimuli were presented at once, children, but not adults, had difficulty, except when a stimulus cue was made available to them. This cue was thought to facilitate systematic processing of the information. This evidence, however, was only suggestive, since only a cue for a strategy was made available. A systematic attentional strategy was not directly trained and recorded.

Just as being trained to attend selectively and systematically to a stimulus feature should facilitate learning and memory, so at the perceptual level, performance should be better when the perceptually salient features are informative than when they are not. However, when selective attention is directed one way by stimulus saliency and another way by logic, logic should override perceptual saliency, since it should be more reliably related to reward in any given task. Because perceptual saliency as a basis for attention will come to be replaced by logical considerations when they are available, there are restrictions on the conditions under which perceptual saliency should have effects on selective attention and

thereby on learning and immediate recognition. Perceptual saliency effects should be detected primarily (a) with younger rather than older children, (b) with children who are not given a logical, selective, attending strategy as compared with children who are given such a strategy, and (c) in the early phases of a task when neither the stimuli nor the task are familiar and a systematic strategy has not been developed.

The following study investigated two methods for establishing a systematic, selective, attending strategy in a memory task. One method was direct training of a specific strategy, employing instructions, fading, modeling, and prompts to direct the child's attention to the relevant features and to organize systematic looking behavior. The second method involved the design of stimuli so that the relevant features were perceptually more (or less) salient.

It was predicted that the second method would be more effective for younger children than older children and for children not given strategy training than for those who were given training. It was also predicted that stimulus saliency would show its effects only relatively early in the task when a systematic strategy has not yet been developed, or only early in a problem when a stimulus is being perceived rather than retrieved from memory. Finally, it was predicted that direct training of a logical strategy would be more effective than stimulus saliency in establishing systematic attention and correspondingly better recognition in all age groups.

## METHOD

### Design

Children were given a memory task in which they were presented a standard stimulus for inspection which was then removed from sight. Then the child was asked to locate from memory the standard stimulus in an array of six alternatives. The alternatives and the standard consisted of house fronts containing three windows in a vertical column through which stimuli were back-projected. Each window was covered by a flap, which when opened, allowed the child to observe the contents of the window. The opening of window flaps was recorded as observing behavior.

The contents of the top windows of each house varied among the six alternatives in the array. Only one was identical to the standard viewed previously. For example, the top window of the standard house might contain a toy train. Then the top windows of the six houses in the array would contain varying objects such as a toy plane, a toy car, a toy typewriter, etc., with one house containing a toy train identical to that in the standard. The contents of the middle windows were uniform for all six houses in the array and the sample within a trial, but varied between trials. For example, the middle window of all the houses might contain a bowl of flowers on one trial and a drum on another trial. The contents of the bottom windows of all the houses were invariant both within and between trials. Hence the contents of the top windows were always relevant for a correct match, while the contents of the middle and bottom windows were invariant and

irrelevant, with the irrelevancy of the bottom windows being more obvious than that of the middle windows.

Two training conditions were used in each of the three saliency conditions (see Table 1). Half of the subjects were taught an observing response strategy of looking at only the relevant window of each house. The other half were given only placebo practice without strategy training. In addition, for one-third of the subjects in each of these groups, the top (relevant) windows were physically salient; for another third of the subjects the irrelevant middle windows were salient; and for the remaining subjects no windows were salient. Finally, there were two age groups, one young and one old. There were thus six groups at each of two age levels in a 2 x 3 x 2 factorial design.

Subjects

The subjects were sixty children between three years, five months and five years, seven months in age. They were obtained from a local day care center and from the Preschool Laboratory at the University of Kansas. They were divided at the median age (four years, six months) into two groups. The mean age for the younger subjects was four years, and the mean age for the older subjects was five years, one month. Three subjects who declined to cooperate were replaced. Two more subjects were replaced due to apparatus failure and experimenter error.

Apparatus

The apparatus consisted of masonite boards, painted green, to which "house fronts" were attached (see Figure 1). One board,

TABLE 1

DESIGN

| | | Stimulus Saliency Relevant | Stimulus Saliency Irrelevant | Control (No Salient Windows) |
|---|---|---|---|---|
| Young | Strategy Training | | | |
| | Placebo Practice | | | |
| Old | Strategy Training | | | |
| | Placebo Practice | | | |

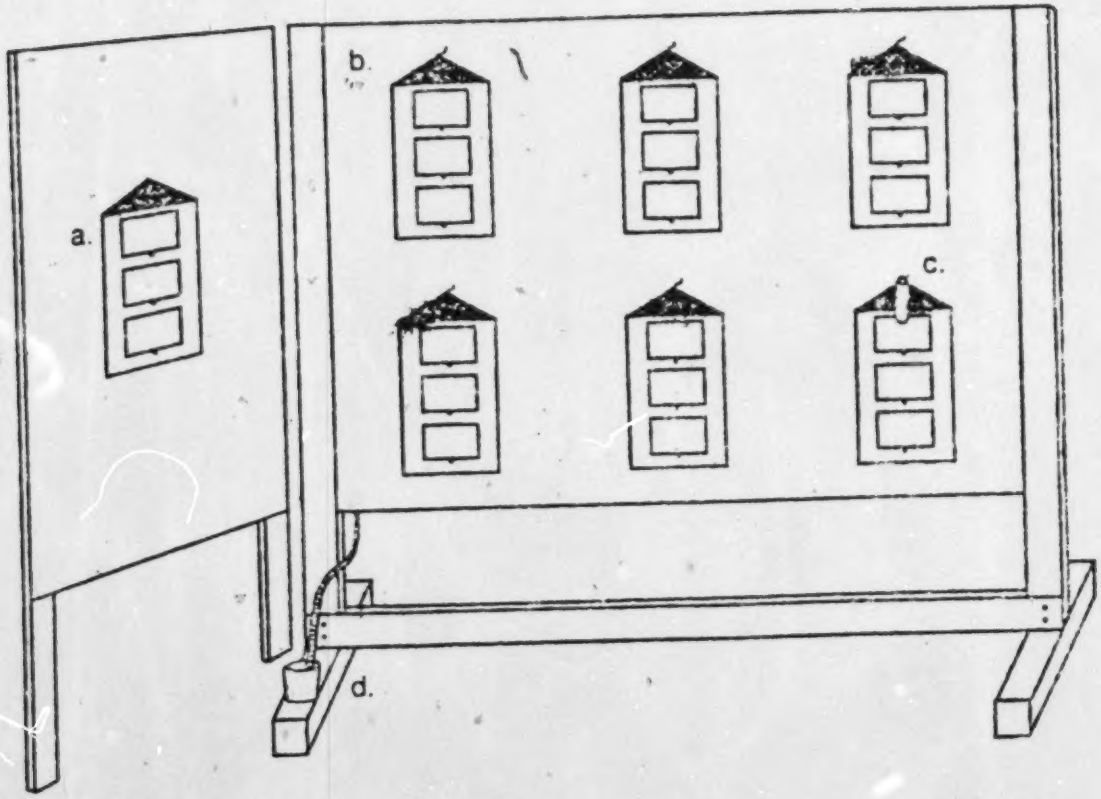


Fig. 1. Apparatus for a Control (no salient windows) condition: a. Standard stimulus, b. comparison array, c. hook with tag on house to indicate choice, d. marble delivery tube and bowl.

the standard, was 18 inches wide by 40 inches high, and contained a single house front. Three other boards, comparison boards, 32 inches wide by 40 inches high, contained six house fronts each. One such board was used for each saliency condition. The boards were placed on vertical stands so that they were approximately 18 inches from the floor. The standard was located to the left of the comparison board. All house fronts were 13 1/2 inches high by 5 1/8 inches wide. They were of a light purple color with orange roofs. Each house had three windows arranged in a verticle column. The six house fronts on the comparison boards were placed in two rows of three, approximately five inches apart horizontally and one inch apart vertically. The apparatus for a given session thus consisted of an appropriate house front on the standard board and a corresponding array of identical house fronts on a separate comparison board.

The house fronts were a static display for any given session. The specific stimuli were back-projected onto translucent material covering the back side of each window in each house. Thus the houses appeared the same from trial to trial, with only the projected figures in the windows being changed. The objects in the three windows of the standard house were contained on a single 2 x 2 inch slide displayed by a carousel slide projector behind the standard board. The 18 objects shown in the six comparison array house fronts (three windows each) were cut from color transparencies and mounted on acetate sheets covered by a glass plate, and were projected onto the back of the comparison board by an overhead projector so that each object appeared in one window.

Each house in the array of houses had a hook at the top, on its roof, on which the subject could place a tag to indicate his choice response. Each window in each house was covered by a translucent flap made of projection plastic and attached to the front of the house (subject's side) just above the window. The flap revealed only a fuzzy image of the object projected in the window until it

was lifted by the subject. Flaps were hinged at the top and could be grasped by a tab at the bottom and thus were easily raised by the subject, one at a time, to reveal the focused image beneath. A flap-opening thus constituted a recordable observing response.

In the Control condition, all three windows of each house were of the same size, two inches high by two and three-fourths inches wide. In the Saliency Relevant condition, the top windows (relevant) were larger, two and one-half inches by three and five-eighths inches wide, and the middle and bottom windows were of the same size as the windows in the control condition. In the Saliency Irrelevant condition, the middle window (irrelevant) was large (of the same dimensions as the large window in the Saliency Relevant condition) and the top and bottom windows were of standard size. The flaps on the salient windows were also distinguished by their yellow color, while all other window flaps were white. Whenever a set of windows (top or middle) were made salient (larger and yellow) all of the corresponding windows in both the standard house and the six comparison houses were similarly treated. A 22 inches wide by 42 inches long cloth was attached to the top of the standard and another cloth (36 inches wide by 42 inches long) was attached to the array so that the stimuli could be covered and hidden from the subject's view.

Stimuli

There were three sets of stimuli, a warmup set of four stimuli, a training series of 12 stimuli, and a transfer series of 12 stimuli (see Table 2). The warmup stimuli consisted of circles and triangles. The training and transfer stimuli consisted of various

TABLE 2

STIMULI

Training Stimuli

| Category of Top-Window Stimuli | Middle-Window Stimulus | Bottom-Window Stimulus |
|---|---|---|
| Wastepaper Baskets | Socks | Globe |
| Dishes | Chicken | Globe |
| Tabletop Objects | Gloves | Globe |
| Toys | Bowl of Flowers | Globe |
| Stringed Musical Instruments | Book | Globe |
| Purses | Pan | Globe |
| Clothes | Football | Globe |
| Plants | Footstool | Globe |
| Bookcases | Basket | Globe |
| TV Sets | White Box | Globe |
| Astrology Pictures | Drum | Globe |
| Tables | Toaster | Globe |

Transfer Stimuli

| | | |
|---|---|---|
| Coffeepots | Girl | Box of Detergent |
| Chairs | Pillow | Box of Detergent |
| Toilets | Typewriter | Box of Detergent |
| Fireplaces | Teddy Bear | Box of Detergent |
| Tools | Decorative Box | Box of Detergent |
| Appliances | Acquarium | Box of Detergent |
| Clocks | Candle | Box of Detergent |
| Record Players | Cat | Box of Detergent |
| Beds | Food | Box of Detergent |
| Babies | Stove | Box of Detergent |
| Lamps | Dog | Box of Detergent |
| Dressers | Sewing Machine | Box of Detergent |

pictures of objects cut out from magazines and then photographed and made into color transparencies. The location of the correct stimulus in the array was randomized across trials with the restriction that the correct stimulus appear in each of the house positions once in each block of six training or transfer trials. Stimuli were chosen on the basis of a pilot study so that they were discriminable by three and four-year-old children. The stimuli in the top-floor windows of the comparison array were all discriminably different examples of the same category, with only one stimulus matching the standard stimulus in the top window. The stimuli in the middle-floor windows were identical for the standard and the six comparison houses within trials but varied between trials. Thus they yielded no differential cues. The stimuli in the bottom-floor windows were also identical for the standard and all comparison houses, and thus were equally uninformative. However, they were invariant not only across the array within trials, but also across all trials. A world globe was in the botton windows in the training series and a box of laundry detergent was in the bottom windows in the transfer series.

Procedure

At any given point in a trial only the standard or the array was presented to the subject's view. At the beginning of a trial the standard was uncovered and exposed to the child for as long as he wanted to look at it. When the child stopped opening windows and looked away from the standard, or when the child otherwise indicated that he was ready to find "his house" in the array, the standard was

covered, and after a two to three second interval the array was uncovered. After the child had made a choice response the array was again covered.

All subjects were given four warmup trials with simple geometric stimuli to establish a discrimination set and an appropriate choice response. The choice response consisted of placing a tag on one of the hooks located on the roof of each of the comparison houses. All correct responses were reinforced with marbles, which were traded in at the end of the game for a small prize. There followed 12 training items. During warmup and the first two training items, the comparison array was reduced to only three houses with the top vs. bottom row location of the three houses randomized across trials. On all of the remaining items all six house fronts were used. For all subjects, during training, whenever a subject made an error, he was re-presented the preceding item. If a subject made an error on the same item and was re-presented a previous slide three times in a row, on the following trials he was re-presented the slide on which he made an error until he responded correctly. Hence a subject advanced through the series only when he made a correct response. When the subject had made a correct response to each of the training items the session was ended. If a session lasted more than 15 to 20 minutes the session was terminated without completion of training. If a subject required more than one training session, the following session started on the last correct item of his preceding session. However, if a subject's response was correct on the last two items of the training series, the following session

started on the next to last slide of the previous session. This provision helped to equate the number of training trials across subjects. The instructions for the task are located in Appendix A.[3]

The transfer series of stimulus items was given in the next session after completion of the training series. Just prior to transfer, however, the subject was given a review of training, consisting of presentation of the last three training items. The backup procedure following errors was used (though rarely needed) in the three review items, but not on the transfer items.

An observer recorded the following variables: The number of observing responses to the relevant and irrelevant windows; the duration of the subject's observing response to the top-floor window of the standard house front (during inspection); the latency of the subject's recognition choice (timed from when the subject opened the first window flap); and his recognition accuracy. The experimenter also recorded looking behavior. All sessions were tape recorded.

Strategy Training. Strategy training consisted of a combination of modeling, fading procedures, and verbal instruction. On the first four trials (warmup) the subject was asked to point to a house with a stimulus in its top window in order to develop a simple discrimination and an appropriate indicator response. For this purpose, on these trials, only the top window of the standard contained a stimulus, and the other two windows were dark. In the array, all middle and bottom windows were also dark, and only one top window contained a stimulus. This stimulus always matched the standard, so that only a presence-absence discrimination was required. Stimuli were introduced in the

top windows of the other houses on the first training trial. On this item, the experimenter demonstrated a strategy of looking at all of the top windows, clearly identifying and labeling the stimuli, and then choosing the correct house. Array exhaustion (looking at all of the top windows, clearly identifying and labeling the stimuli, and then choosing the correct house. Array exhaustion (looking at all comparison houses before choosing one) was prompted during the first four training items. This prompting was discontinued after the fourth training item. In addition, the subject was asked to label the contents of the top window of the sample house, to look at it carefully, and to try to remember it so that he could find it later. Following each look to an irrelevant window, the subject was reminded that such looks were uninformative. This procedure was in effect for warmup and training, but was rarely needed after trial 8. On the seventh training item the stimuli in the middle and bottom windows were for the first time made dimly visible by projecting their images through polaroid plastic, while all top windows continued to display stimuli at full brightness. On this item, the redundancy of the contents of the middle and bottom windows was explained to the subject and he was told that he therefore needed to look only in the top windows. On training item 10 and thereafter for the remainder of the training and test items, the stimuli in all windows were projected at full brightness.

Placebo Practice. Subjects in the Placebo condition were given instructions to match the standard. The stimuli were projected in all of the windows at full strength throughout. No relevancy

instructions, no prompts, and no modeling of array exhaustion of the top windows was given. Placebo subjects were, however, reminded to try to remember the standard and find its match in the array.

Transfer Items. The 12 transfer items were all new, and were constructed and displayed exactly the same as the last three training items. Strategy and Placebo subjects were treated identically; no prompts or reminders were given; marbles were delivered following correct responses; no back-up procedure was employed following errors; and all stimuli were present at full illumination. The saliency conditions were continued as in training. The same observing and choice response variables were recorded.

## RESULTS

### Dependent Variables and Reliability

Analyses of variance were computed on two measures of recognition accuracy and on a number of measures of the subjects' looking behavior. The measures of recall accuracy consisted of the number of trials needed to complete the training items and the total number of errors in training and also in transfer. Looking behavior was analyzed separately for the standard and for the array of alternatives. The measures of looking behavior at the standard included the total number of looks at the top window, the total number of looks at all three windows, the proportion of the total number of looks directed to the top window, and the length of time spent looking at the top window. The measures of looking behavior for the array consisted of the total number of looks at top windows, the total number of looks, the proportion of the total number of looks directed to top windows, the proportion of the total number of top windows in the array that were observed at least once, and the latency from array exposure to choice. Summary tables for these analyses of variance are located in Appendix E.

Observer reliability on looking behavior was analyzed. Six subjects were selected for reliability assessment. They were distributed over the period of data collection and chosen so that the different types of training conditions and age groups were approximately equally represented. The combined observer reliability (for the standard and the array) was .97 for training and .98 for transfer (two times the number of agreements divided by the sum of the looks recorded by the experi-

The combined observer reliability (for the standard and the array) was .97 for training and .98 for transfer (two times the number of agreements divided by the sum of the looks recorded by the experimenter plus those recorded by the observer). The experimenter's record was used for analysis except when that record was incomplete (seven records). For those sessions the observer's protocol was used.

Training

Recognition Accuracy. The results indicated a strong effect of strategy training for children at both age levels. Strategy subjects required fewer trials to complete training than did Placebo subjects ($F$ (1,48) = 19.61, $p < .001$). The mean trials to criterion were 15.83 and 46.33 respectively. Strategy subjects also made fewer errors than did Placebo subjects ($F$ (1,48) = 37.55, $p < .001$) as indicated in Figure 2. There was also a significant main effect of stimulus saliency on errors ($F$ (2,48) = 4.09, $p < .05$, one-tailed test). By multiple $t$ tests, subjects in the Saliency Irrelevant condition made significantly more errors than subjects in the Control ($t$ (38) = 2.51, $p < .01$, one-tailed test) and the Saliency Relevant ($t$ (38) = 2.44, $p < .01$, one-tailed test) conditions. This difference was due to the larger number of errors made by Placebo subjects in the Saliency Irrelevant condition, as evidenced by the significant saliency by type of training interaction ($F$ (2,48) = 5.41, $p < .01$) depicted in Figure 2. Placebo subjects in the Saliency Irrelevant condition made more errors than Placebo subjects in the Control condition ($t$ (18) = 3.61, $p < .01$, one-tailed test) and the Saliency Relevant condition ($t$ (18) = 3.90, $p < .005$, one-tailed test),

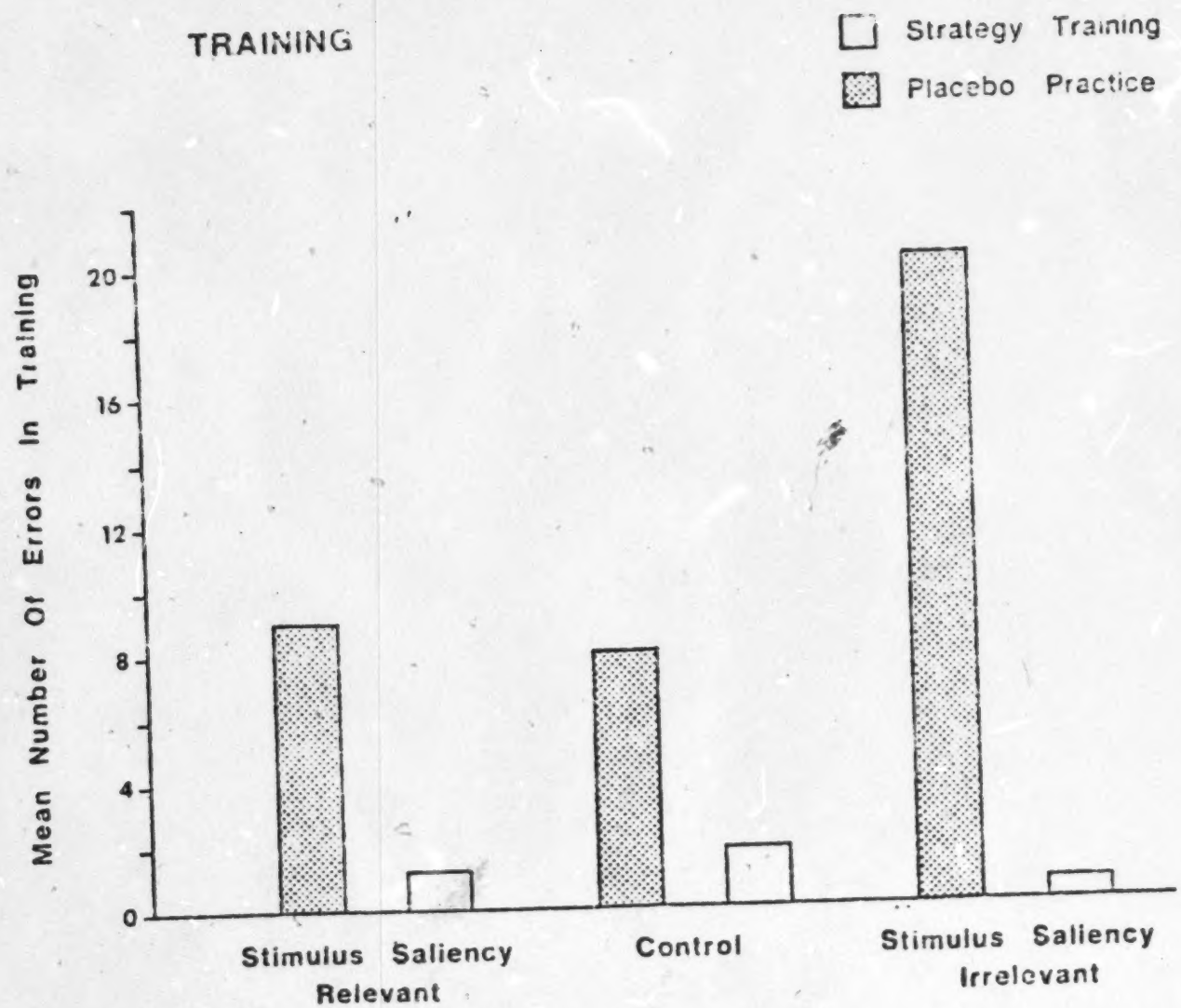


Fig. 2. The mean number of errors in training for Strategy and Placebo Subjects in the Stimulus Saliency Relevant, Control and Stimulus Saliency Irrelevant conditions.

a difference not found among Strategy subjects. The Placebo subjects in the Saliency Irrelevant condition also made significantly more errors than Strategy subjects in all conditions (see Table 9, Appendix B). Strategy subjects showed only nonsignificant effects of stimulus saliency.

Looking Behavior. The training data on looking behavior were analyzed on comparable sets of six trials for Placebo and Strategy subjects. These sets of trials consisted of the last six trials of training for the Strategy subjects and trials 11-16 for the Placebo subjects. The last six trials were chosen for the Strategy subjects because on these trials stimuli appeared in all of the windows of the houses and prompting was minimal. These conditions were similar to those for the Placebo subjects. Trials 11-16 were chosen for the Placebo subjects to equate the groups for approximately the amount of time spent on the task. This set of trials was selected by determining the mean number of trials necessary to complete training for the Strategy subjects (16 trials) and by counting back five trials.

The looking behavior of the subjects was analyzed separately for the standard and the array of alternatives. Overall, Strategy subjects looked at the top window of the standard significantly longer than did Placebo subjects ($F$ (1,48) = 16.30, $p < .001$). They also looked at significantly fewer windows of the standard ($F$ (1,48) = 116.33, $p < .001$) than did Placebo subjects and devoted a greater proportion of their total number of looks to the top window ($F$ (1,48) = 446.30, $p < .001$). There were no significant main effects of age and stimulus saliency. The results for the above variables are summarized in

Table 3.

Figure 3 depicts a significant interaction between age and stimulus saliency for the proportion of the total number of looks directed to the top window of the standard ($F$ (2,48 = 3.59, $p < .05$). Young children devoted a significantly larger proportion of their looks to the top window when it was salient than when the middle window was salient ($t$ (18) = 2.66, $p < .01$, one-tailed test). There was no significant effect of saliency for the older subjects, although there was a trend in the opposite direction. In addition, the younger subjects devoted a greater proportion of their looks to the top window when salient than the older subjects ($t$ (18) = 1.84, $p < .05$, one tailed-test), and a lower proportion of their total number of looks to the top window than the older subjects when the irrelevant middle window was salient ($t$ (18) = 1.96, $p < .05$, one-tailed test). In other words, the younger subjects were influenced by the saliency of the relevant and irrelevant windows more than the older subjects. There were no significant differences in the total number of top windows observed. This was largely due to a ceiling effect; all subjects looked at the top window of the standard.

On the array of alternatives, Strategy subjects made fewer total looks at the windows in the array than did Placebo subjects ($F$ (1,48) = 43.62, $p < .001$), but there were no significant differences between groups in the raw number of looks at top windows. Therefore, Strategy subjects devoted a much higher proportion of their looks to top windows than did Placebo subjects ($F$ (1,48) = 1591.74, $p < .001$). Moreover, Strategy subjects had shorter latencies to choice than did Placebo subjects ($F$ (1,48) = 18.46, $p < .001$). The results on these variables

Table 3

Looking Behavior to Standard in Training

| | Strategy Training | Placebo Practice |
|---|---|---|
| Mean Duration of Looks at the Top Window | 37.92 | 13.28 |
| Mean Number of Looks at All Windows of the Standard | 6.83 | 18.47 |
| Mean Proportion of Total Looks Directed to the Top Window | .97 | .38 |

*Saliency conditions and age groups are combined.

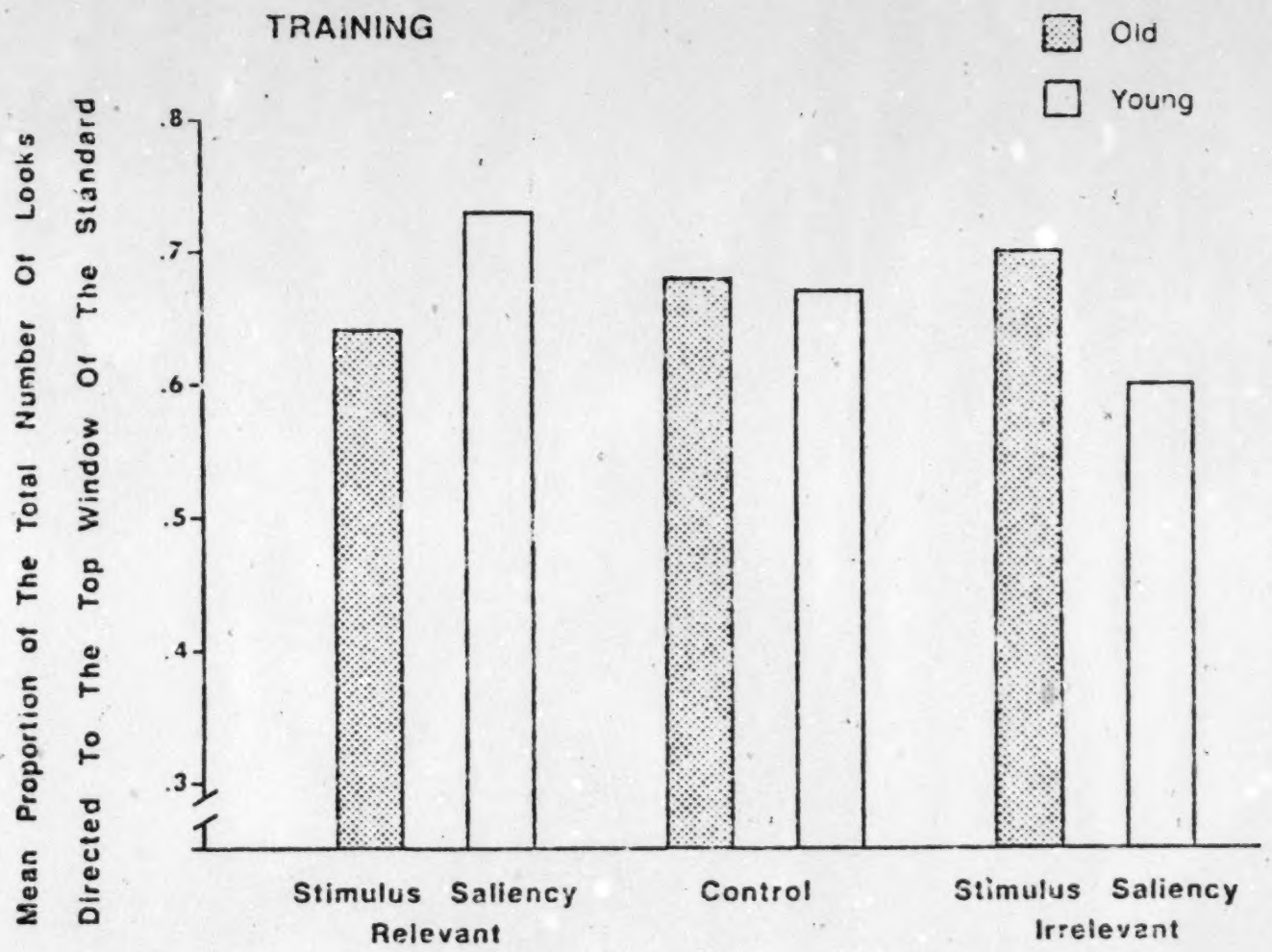


Fig. 3. The mean proportion of the total number of looks at the standard in training that were directed to the top window in the three saliency conditions for young and old subjects.

are summarized in Table 4. Again, there were no significant main effects or interactions involving age or saliency.

When the data were analyzed for the proportion of different top windows available that were observed at least once (percent array exhaustion), there was an interaction between type of training and age ($F$ (1,48) = 4.94, $p$ < .05). Younger Placebo subjects looked at a greater proportion of the different top windows available (Mean proportion = .82) than did the older Placebo subjects (Mean proportion = .68), ($t$ (28) = 1.73, .05 < $p$ < .10, two-tailed test). This effect was not present for the Strategy subjects. The younger Strategy subjects looked at a mean proportion of .69 and the older Strategy subjects looked at a mean proportion of .80 of the different top windows available.

Transfer

Data were analyzed for all 12 trials of the transfer task (excluding the review of training).

Recognition Accuracy. Overall, Strategy subjects made significantly fewer errors in transfer than did the Placebo subjects ($F$ (1,48) = 31.74, $p$ < .001). Strategy subjects had a mean of 2.80 errors in transfer and Placebo subjects had a mean of 5.73 errors in transfer. There were only nonsignificant effects of age and stimulus saliency.

Looking Behavior. Overall, Strategy subjects had fewer looks at the windows of the standard than did the Placebo subjects ($F$ (1,48) = 158.46, $p$ < .001), but there was no difference between the groups in the total number of looks to the top window of the standard. Hence, the Strategy subjects devoted a greater proportion of their looks to the top window of the standard house than did the Placebo subjects ($F$ (1,48) = 235.16, $p$ < .001). The Strategy subjects also looked at

Table 4

Looking Behavior at the Recognition Array in Training

| | Strategy Training | Placebo Practice |
|---|---|---|
| Mean Number of All Looks at Windows in the Array | 32.60 | 78.67 |
| Mean Number of Looks to Top Windows in the Array | 31.70 | 28.70 |
| Mean Proportion of the Total Number of Looks Directed to Top Windows in Array | .98 | .37 |
| Latency to Choice in sec. | 138.62 | 285.83 |

*Saliency and age groups are combined.

the top window of the standard longer than the Placebo subjects ($F$ (1,48) = 15.58, $p < .001$). There were no significant main effects of age and stimulus saliency. These results are summarized in Table 5.

As in training, there was a significant interaction between age and saliency for the proportion of the total number of looks devoted to the top windows of the standard ($F$ (2,48) = 3.21, $p < .05$). This interaction is depicted in Figure 4. Older subjects devoted a significantly larger proportion of their looks to the top windows when the middle window was salient than when the top window was salient ($t$ (18) = 2.23, $p < .05$, two-tailed test). There were no such significant effects for the younger subjects, although there was a trend in the opposite direction. Older children devoted a significantly larger proportion of their looks to the top window when the middle window was salient than did younger subjects ($t$ (18) = 1.81, $p < .05$, one-tailed test).

When looking at the array of alternatives in transfer, Strategy subjects followed the routine of looking at only the top windows. They made significantly fewer total looks than did Placebo subjects ($F$ (1,48) = 44.83, $p < .001$), but devoted a greater proportion of those looks to the top windows ($F$ (1,48) = 255.49, $p < .001$). In addition, Strategy subjects had significantly shorter latencies to choice than did the Placebo subjects ($F$ (1,48) = 18.19, $p < .001$). There were no significant differences in the total number of looks at the top windows or in the proportion of different top windows observed at least once in the array. The effects of age and saliency on these variables were nonsignificant. The means for the Placebo and Strategy subjects in the above variables are summarized in Table 6.

Table 5

Looking Behavior to Standard in Transfer

| | Strategy Training | Placebo Practice |
|---|---|---|
| Mean Duration of Looks at the Top Window | 60.16 | 30.38 |
| Mean Number of Looks at All Windows of the Standard | 12.90 | 36.27 |
| Mean Proportion of Total Looks Directed to the Top Window | .98 | .41 |

*Saliency conditions and age groups are combined.

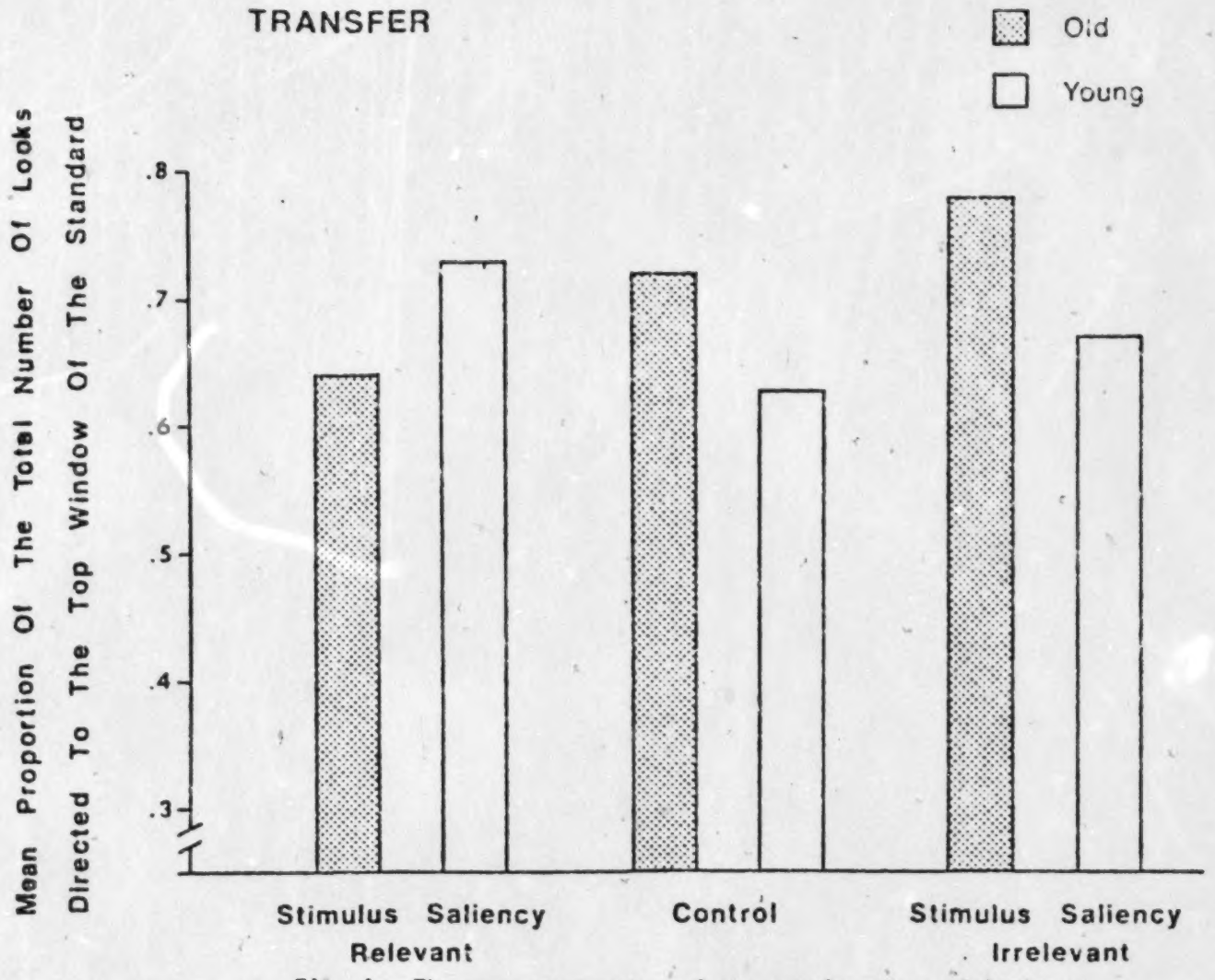


Fig. 4. The mean proportion of the total number of looks at the standard in transfer that were directed to the top window in the three saliency conditions for young and old subjects.

Table 6

Looking Behavior at the Recognition Array in Transfer

| | Strategy Training | Placebo Practice |
|---|---|---|
| Mean Number of All Looks at Windows in the Array | 71.20 | 161.83 |
| Mean Number of Looks to Top Windows in the Array | 70.03 | 64.97 |
| Mean Proportion of the Total Number of Looks Directed to Top Windows in Array | .98 | .45 |
| Mean Number of Different Top Windows Observed | 54.07 | 57.63 |
| Latency to Choice in sec. | 267.77 | 461.01 |

*Saliency and age groups are combined.

There were no significant differences in looking behavior between training and transfer. Only four children, all older subjects in the Placebo condition, showed an increased proportion of looks at top windows.

## DISCUSSION

### Effects of Strategy Training

Strategy training, as predicted, produced more selective observing behavior, faster learning in training, and better recognition in training and transfer than did placebo practice. Furthermore, strategy training had more wide ranging and stronger effects than did stimulus saliency.

Strategy training may have had very strong effects because it consisted of several concurrent manipulations. These manipulations included fading, modeling, verbal instructions, and prompting. Some of these components, such as modeling and fading, may have been more compatible with the younger child's more perceptually based nonverbal approach to the task. Other components, such as verbal instruction and prompting, may have been more compatible with the older child's more verbally-based orientation. Further research is needed to determine the effectiveness of each of these components of strategy training for young and old children.

The selective focusing of attention attained under conditions of strategy training for three-year-olds was similar to the selectiveness of attention found only in much older children in other studies (Lehman, 1972; Pick, Christy, & Frankel, 1972). In such studies, no instructions or only verbal instructions were given (e.g. Lehman, 1972).

This outcome does not demonstrate that the preschool child lacks the capacity for developing selective attentional strategies. Instead the preschooler appears to have difficulty in distinguishing relevant from irrelevant information, in inhibiting a motoric response to irrelevant information, especially when it is perceptually salient, and in establishing a systematic routine for observing the stimuli in the absence of strategy training. When given experiences compatible with his usual mode of response and designed to develop a systematic attending strategy, he can perform as well as much older children.

Both the Strategy and Placebo subjects, by the time they had completed training, had some routine for performing the task. For the Strategy subjects it was to look at the top windows. Placebo subjects tended to open each window, top, middle, and bottom, of each house, and then make a choice. This type of observing behavior was not as efficient as that of the Strategy subjects because it took more time and required more looking behavior. Nonetheless, it was a systematic routine, and like the trained strategy, it served to eliminate the effects of saliency. Although the Placebo subjects took many more trials to complete training than did the Strategy subjects, the Placebo subjects completed training and achieved a similar level of competence in performing the task. Once a systematic strategy for performing the task had been established, stimulus saliency was no longer an important variable.

Young Placebo subjects in training looked at a greater proportion of the available top windows at least once than did the older

Placebo subjects. There was no difference on this variable (exhaustion of the array) for the Strategy subjects. This effect may be due to the fact that some of the younger Placebo subjects appeared to be playing a game of "open each window and name the picture" rather than performing the task of "find your house." Hence the younger subjects looked at more different top windows than did the older children, who merely looked until they found the correct house. A comparison of the strategies of the Strategy and Placebo subjects in transfer suggests that the selectiveness of attention involved in the strategy of looking at only the top windows was more important for accurate recognition in this study than was the exhaustiveness of the strategy.

It is interesting to note that the Placebo subjects, whose routine was to open all of the windows and then make a choice, had in effect a strategy which enabled them to recall the relevant information but did not exclude the irrelevant information. A study with older children might determine whether the most important developmental change in attention that occurs with age is an improved ability to recall information or to exclude irrelevant information. Current data favor the latter.

Effects of Stimulus Saliency (Relevant and Irrelevant)

Stimulus saliency had an effect on errors in training, but not on the number of trials needed to complete training. It had an effect on observing behavior in both training and transfer, but only in the early part of each trial when the subjects were observing the contents of the standard house. Saliency did not affect the proportion of the

total looks that were directed to the relevant windows of the array. These results are consistent with the hypothesis that stimulus saliency has more transient effects than logical task strategies once they are developed. They also support the notion that saliency as a determinant of attention is replaced by systematic observing strategies when they are available.

In training, the looking behavior of the younger children was affected more by the saliency of the top and middle windows of the standard than was that of older children. These results support the hypothesis that saliency plays a more important role when stimuli are being initially perceived than when they are being matched from memory. In transfer, older children looked at the top window more when the middle window was salient. There also was a nonsignificant trend for the same type of responding among the older children in training. The saliency of the middle window may have served to remind the older subjects of the irrelevancy of the middle and bottom windows and therefore, to avoid looking at them. This would be an indirect effect of saliency at a logical, rather than a perceptual level. When saliency worked in a direct fashion, however, it attracted attention only in younger children, as predicted.

It is important to note that logical strategies may not always be superior to stimulus saliency as a means of organizing attention. Whether stimulus saliency or a logical task strategy is a more efficient determinant of attention may depend on the nature of the task. The task in this study placed more demands on the child's cognitive capacities than would a more perceptual task. Perhaps

in a more perceptual task, stimulus saliency would play a more enduring role.

For the Placebo subjects, the Saliency Irrelevant condition increased the number of errors more than the Saliency Relevant condition reduced it. Luria (1961) and White (1965) have suggested that the main problem in children's discrimination learning is a lack of inhibitory mechanisms. White (1965) argues that children under age five typically respond to a stimulus situation automatically and with the first available response. Later in development, this type of response becomes superseded by a more cognitive and abstract level of response. At the latter level, the previously automatic response may be inhibited so that a more complex decision process may determine behavior. Behavior at the cognitive level of response appears to be more systematic and planned, and in a task situation is usually more reliably correlated with reward. Subjects in the [illegible]ant condition may have had difficulty in inhibiting their attention to the irrelevant stimulus.

However, Placebo subjects in the Saliency Irrelevant condition did not open irrelevant window flaps any more than did the Placebo subjects in the Control or Saliency Relevant condition. It may be that the Placebo subjects in the Saliency Irrelevant condition matched sometimes on the basis of the middle windows, all of which were the same as the middle window of the standard, so that they responded correctly only by chance, or that they matched partly on the basis of the contents of the top and middle middle windows which was confusing and more likely to result in erroneous responses.

An analog of White's (1965) developmental shift from a fast-acting associative level of response to a more cognitive level of response was found at a single age level for the Placebo and Strategy subjects in this study. Placebo subjects, like young children, were

acting at a more associative level of response. Strategy subjects, on the other hand, were trained to inhibit their response to the irrelevant stimuli and were given an attentional strategy whereby they could efficiently find the correct stimulus. In this way they resemble the older children described by White's (1965) hypothesis.

Conclusions

In summary, at least for the task studied here, it appears that perceptual saliency of stimulus features is a more transient determinant of selective attention than is a systematic logical scanning routine, regardless of how that routine is acquired by the child. The evidence for the transcience of perceptual saliency determinants lies in three findings: (a) younger children were more susceptible to direct saliency effects than were older subjects, (b) saliency effects were more evident during training than during transfer, especially for Placebo subjects, and (c) saliency effects on the initial inspection of the standard on each trial continued over more trials than did such effects on searching the recognition array.

Secondly, while all subjects eventually developed some appropriate routine for systematically attending to relevant features, the strategy of selectively attending only to relevant cues as taught to Strategy subjects was more effective in promoting rapid progress through training and reducing errors.

Finally, the massive effects of the strategy training package demonstrated in this study probably resulted from the differential effectiveness of the separate components. Some of these may have been more effective for younger and others for older children. The systematic differentiation of these effects is of top priority for the next study in this series.

## FOOTNOTES

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3. Appendices are not included in this paper. Interested persons may obtain the appendices from the author (address above).

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